THE MEASUREMENT OF VARIATIONS IN THE NATIONAL REAL INCOME*

By Edmund E. Day

The high significance commonly attached to variations in the national real income invites an examination of the means by which such variations are to be measured. Undoubtedly, definite conclusions must await the collection of additional data, along new as well as accustomed lines. But meanwhile various problems of method may be profitably entertained and working rules of analysis provisionally devised.

Variations in the national real income are to be ascertained by two distinct methods. In the first place, measurement of the variations is possible through an analysis of pecuniary aggregates. The national *money* income may be reduced to *real* terms through the process of deflation; that is, through dividing the money income by numbers proportionate to changes in the price level. Since the prices of different lines of goods and services behave differently during periods of general price change, special index numbers for various commodity- and service-groups are necessary if the national real income is to be accurately determined by this method of deflation. It may be questioned whether special index numbers, satisfactory for this particular purpose, are now available. But there is no reason why they cannot be constructed. Once on hand, they would render possible an approximate measurement of the national real income. An early determination of the national real income by this method of deflating the national money income is much to be desired.

The second method of ascertaining variations in the national income is by the process of direct summation of the goods and services. Of course, the goods and services cannot be combined in physical terms. It is impossible to obtain an absolute total of the real income, made up, as it is, of flour and meat, clothing and coal, automobiles and movies, and a thousand and one other diverse objects of desire. The absolute national real income is to be expressed only as a complete list of things consumed; it cannot be stated in a single figure. But *relative variations* in the national real income may be ascertained by combining relatives indicative of the volume of consumption of the different goods and services that constitute the real income. Moreover, such varia-

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tions in the real income may be expressed in a single index number. Some indication of the steps involved in this method of direct summation is provided by the analysis which follows.

Something should be said in the first place regarding the general nature of the national real income. Real income is unmistakably psychological in character. It consists of satisfactions derived from the utilization of goods and services. But what goods and services? The distinctions between free and economic goods, public and private goods, durative and consumptive goods, producers' and consumers' goods, all contribute to an answer. In general, the national real income during a given period consists of the satisfactions derived from the use during that period of consumptive and durative consumers' goods and services, whether publicly or privately distributed.

Obviously, this concept can be only roughly approximated in any statistical measurements at this time. In the first place, measurement of satisfactions is clearly impracticable. Analysis must content itself with measurement of the physical sources, or externals, of such satisfactions—with the concrete goods and services. In the second place, it is impossible to calculate the annual increment from durable goods. The accumulated stock of such goods may be ascertained; or the annual increment of new durable goods may be measured. But the general rate of utilization lies beyond statistical reach. Finally, most services are not now so recorded as to permit of statistical tabulation. True, data may be had on such services as are provided by the railway and telephone systems. But the personal services rendered by lawyers, physicians, teachers, artists, actors, and household servants are indicated only in the numbers occupied in the several branches of professional and domestic service. No available records show variations in service-income due to the varying activity of those engaged in the service-occupations. It is obvious, then, that the national real economic income as statistically measurable is considerably different from the same income as theoretically defined. Nevertheless, in view of the surpassing importance of the subject, an attempt at statistical measurement seems desirable.

So far as the national real income is embodied in goods, the most important single barometer of changes in the size of the income is the physical volume of output in manufacture. This follows from the fact that the great bulk of modern articles of consumption pass at one stage or another through factory processes. Even our foodstuffs—our flour, meat, sugar, coffee—emerge in finished form from industrial plants. Only a few commodities—fresh vegetables and fruits, milk, household coal—are not regarded as in any way manufactured. The production

of all others—the bulk of our food, our clothing, our shelter—involves manufacture. The physical volume of factory output bears a definite relation to the national real income. Examination of an index of the physical volume of manufacture promises to contribute to a knowledge of variations in the national real income.

Such an index has been constructed in the course of an analysis of the physical volume of production for the period 1899 to 1919.* Separate indices have been developed for agriculture, mining, and manufacture. The index for manufacture is based partly upon material drawn from the United States censuses of manufactures for 1899, 1904, 1909, and 1914, and partly upon thirty-five series of annual data, available in practically all cases for the full period 1899–1919. The index takes the form of a weighted geometric mean of relatives obtained by reducing each item of every original series to a percentage of the 1909 item of the series. The index is obtained by a process of integration. Indices for individual industries are secured from series representing single commodity lines. Indices for groups of industries are developed by combining single-industry indices. Finally, the index for all manufacture emerges when the group indices are consolidated Throughout the computations, the weights employed are proportionate to the values added by manufacture as shown in the census of manufactures for the base-year 1909. By means of corrections introduced at two points in the computation, the index based upon annual data is made to conform exactly for census years to the index based upon census data. The more abundant material of census years is thus made into a series of solid abutments upon which the index based upon annual data is suspended. The annual data serve to determine the year-to-year fluctuations of the index; the census data, the general level upon which the index moves.† The index, thus developed (shifted to the base 1899 = 100), is given in full in Table I, and shown graphically in Chart A.

The significance of the index for manufacture is best understood by comparing it with the corresponding indices for agriculture, mining, and population—all shown in both table and chart. The contrasts are striking. In the general course of the physical volume of production, manufacture lies between agriculture upon the one hand and mining upon the other. Agricultural production from 1899 to 1919 increased at a rate almost exactly paralleling the growth of population. The exploitation of our mineral resources, upon the other hand, proceeded at a pace greatly in excess of the rate of increase of population.

* *The Review of Economic Statistics*, September, October, November, December, 1920, January, 1921.

† For complete details regarding the construction of the index of physical production for manufacture, see *The Review of Economic Statistics*, November 1920, pp. 309–337.

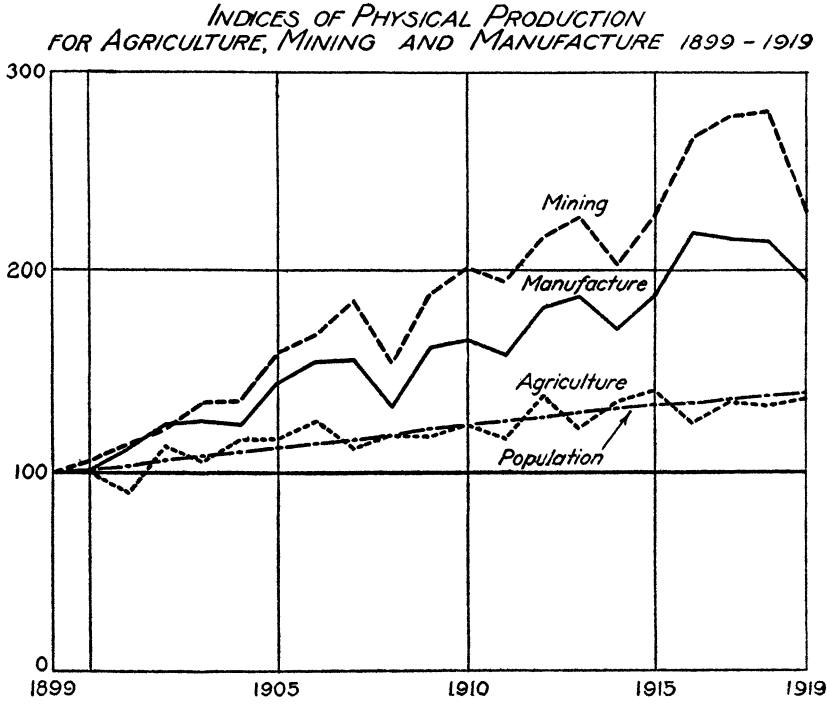
TABLE I

INDEX OF PHYSICAL PRODUCTION FOR MANUFACTURE, COMPARED WITH CORRESPONDING INDICES FOR MINING, AGRICULTURE, AND POPULATION, 1899–1919

(Items for 1899=100)

Year	Index for manufacture	Index for mining	Index for agriculture	Index for population
1899	100.0	100.0	100.0	100.0
1900	101.0	105.7	100.6	101.8
1901	112.4	114.6	89.3	103.8
1902	123.5	122.7	113.7	106.0
1903	125.5	135.0	105.0	108.1
1904	123.2	136.3	116.0	110.3
1905	144.4	161.6	117.5	112.4
1906	155.0	169.9	125.0	114.5
1907	156.3	185.9	112.4	116.7
1908	132.7	154.2	118.8	118.9
1909	163.4	189.4	118.1	121.0
1910	166.0	201.6	123.2	123.1
1911	158.3	194.4	117.0	125.3
1912	181.4	216.7	138.1	127.4
1913	187.1	227.2	122.1	129.6
1914	171.4	202.6	135.0	131.6
1915	187.2	227.6	141.0	133.2
1916	218.6	267.0	124.9	134.8
1917	215.2	277.2	135.0	136.5
1918	214.0	279.6	133.2	138.1
1919	195.3	228.4	137.6	139.7

CHART A



Manufacture, depending for its raw materials partly upon agriculture, partly upon mining, naturally assumes an intermediate position. Its rate of increase has been much more rapid than that of the population and considerably greater than that of agricultural production, but not nearly so great as that of mineral output. In the year-to-year fluctuations, also, distinct differences appear among agriculture, mining, and manufacture. The course of physical production in manufacture is markedly cyclical. The same is true in mining. As might be expected, mining appears to be little more than the handmaiden of manufacture. Agriculture, on the other hand, exhibits fluctuations from year to year which appear to be almost, if not entirely, independent of the business cycle. In general, the differences between the indices are highly significant, and suggestive of fundamental facts relating to variations in the national real income.

But if changes in the national real income are to be clearly recognized, a more detailed analysis must be made. Although the physical volume of production in manufacture has a bearing upon the measurement of variations in the national real income, the bearing is not a clear and direct one owing principally to the fact that the output of manufacture consists of producers' as well as consumers' goods. Stronger light will be thrown upon variations in the national real income if the general index for manufacture is broken into the ten group indices upon which it is based. These ten group indices serve to register fluctuations in the physical volume of production in certain important groups of manufacturing industries recognized in the census classification of manufactures. The ten groups for which sufficient data have been obtained to warrant the construction of indices are those engaged in the manufacture of the following products:*

1. Food and kindred products (1)
2. Textiles and their products (2)
3. Iron and steel and their products (3)
4. Lumber and its remanufactures (4)
5. Liquors and beverages (7)
6. Chemicals and allied products (8)
7. Stone, clay, and glass products (9)
8. Metals and metal products other than iron and steel (10)
9. Tobacco manufactures (11)
10. Vehicles for land transportation (12)

The indices for these ten groups, reduced to the base of 1899 = 100, are given in Table II and presented graphically in Chart B.†

* The figures in parentheses refer to the numbering of the groups in the full census classification. The census groups for which annual data are not available are: (5) Leather and its finished products; (6) Paper and printing; (13) Railroad repair shops; (14) Miscellaneous industries.

† The indices for the lumber and vehicle groups are omitted from the Chart.

TABLE II

INDICES OF THE GROWTH OF POPULATION AND THE PHYSICAL VOLUME OF PRODUCTION OF TEN GROUPS OF MANUFACTURED PRODUCTS, 1899–1919

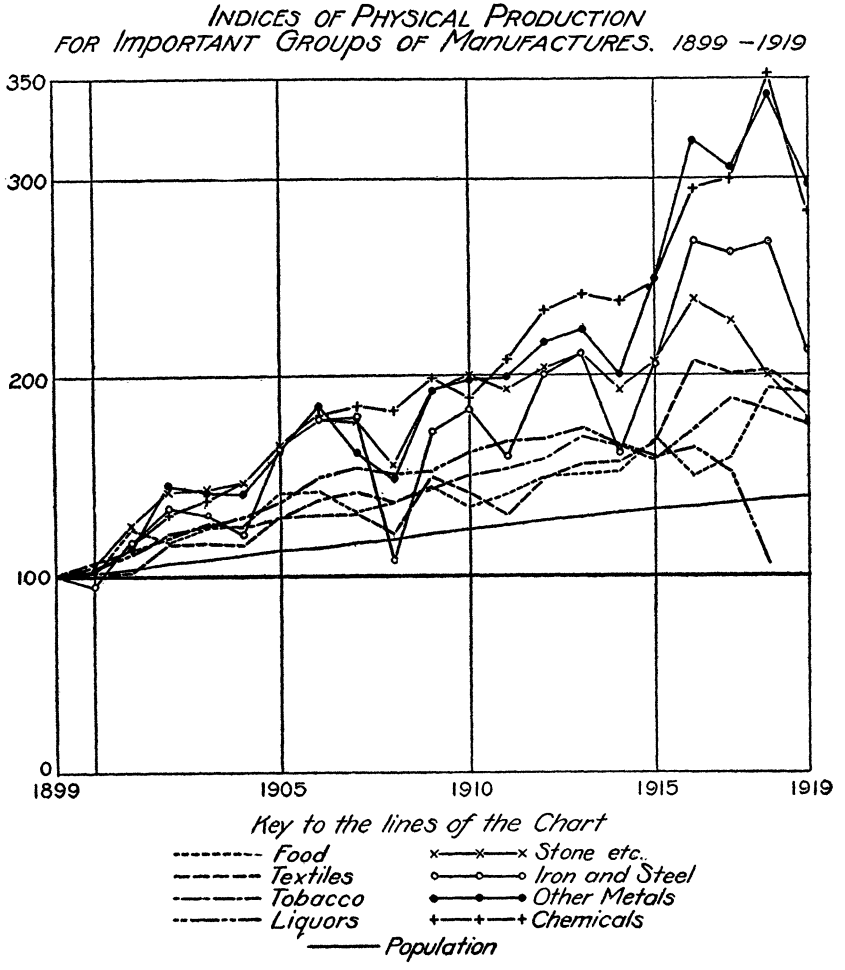
(Items for 1899=100)

Year	Population	Lumber	Food	Textiles	Tobacco	Liquors	Stone, clay, and glass	Iron and steel	Chemicals and allied products	Metal products other than iron and steel	Vehicles
1899..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1900..	101.8	98.1	100.7	100.6	106.5	105.7	105.4	95.5	102.6	102.3	117.4
1901..	103.8	96.2	123.1	101.5	112.0	112.9	125.2	117.5	115.5	113.1	147.2
1902..	106.0	94.3	117.3	116.0	118.1	120.9	142.0	133.3	130.2	145.8	183.3
1903..	108.1	92.4	124.5	116.1	126.0	125.6	143.1	130.2	138.6	142.4	210.3
1904..	110.3	90.7	125.0	115.8	124.8	129.4	146.8	120.4	146.6	141.4	186.5
1905..	112.4	97.4	141.3	129.2	128.4	137.6	165.3	164.2	165.5	163.9	284.4
1906..	114.5	109.1	142.1	130.4	138.2	149.4	178.4	178.7	180.4	184.7	356.7
1907..	116.7	115.8	132.2	131.9	141.8	153.6	177.4	179.7	184.4	161.8	430.5
1908..	118.9	112.4	136.2	121.5	136.3	149.3	155.3	107.7	182.0	148.5	286.8
1909..	121.0	126.2	144.3	149.2	143.6	151.5	192.6	171.8	199.2	192.6	354.5
1910..	123.1	123.2	134.3	141.2	150.7	161.6	200.7	183.2	189.6	198.4	522.2
1911..	125.3	116.1	140.4	130.3	153.7	165.6	193.2	159.6	208.3	199.0	377.6
1912..	127.4	118.7	149.5	148.4	158.6	168.5	204.0	201.0	233.4	216.3	650.6
1913..	129.6	113.4	151.0	155.8	169.1	173.4	211.2	211.2	240.6	223.9	769.8
1914..	131.6	101.8	152.7	157.3	165.0	164.5	193.8	161.3	238.8	200.3	657.8
1915..	133.2	95.6	169.7	167.8	158.8	158.3	208.6	205.3	247.8	248.1	747.4
1916..	134.8	100.6	150.8	207.6	173.4	163.8	238.1	268.9	294.8	319.0	1304.6
1917..	136.5	90.5	159.5	201.4	188.8	151.2	227.5	262.7	299.0	305.0	1483.3
1918..	138.1	80.4	194.2	202.7	183.0	105.0	200.5	267.9	353.8	343.5	1019.5
1919..	139.7	85.5	191.1	190.7	176.0	....	178.8	212.7	282.2	296.1	1373.8

The outstanding feature of these lesser indices is an unmistakable grouping in the movement of the indices during the pre-war period 1899 to 1913. Examination of the indices shows that, while the index for vehicles rises to an extraordinary height, and the index for lumber remains upon an unusually low level, the other eight indices fall into two well-defined sets,—one consisting of the indices for iron and steel, stone and clay, non-ferrous metals, and chemicals; the other, of the indices for food, textiles, tobacco, and liquors. The distinction between the two sets is clear. The commodities produced in the first set consist primarily of producers' goods; those in the second set, of consumers' goods. It follows, of course, that the second set of group indices has a much more direct bearing upon the national real income than the first.

Careful examination of the various group indices for the full period 1899 to 1919 yields a number of interesting tentative conclusions. In the first place, the production of producers' goods has increased at a much more rapid rate than the production of consumers' goods. Presumably those portions of the national real income which consist of services derived from large-scale plants, such as railroads and telephone systems, share in the very rapid increase of volume which distinguishes the indices of this class. In the second place, it may be concluded

CHART B



that the rapidly increasing output of *producers'* goods, used partly to maintain, partly to enlarge, existing industrial plant and equipment, has the indirect consequence of increasing the domestic manufacture of *consumers'* goods. It is not surprising, therefore, to find the production of consumers' goods apparently increasing more rapidly than the population.* In the third place, the group indices confirm the conclusion, previously drawn, that the manufacture of goods made from mineral raw materials has increased more rapidly than the manu-

* This more rapid increase cannot be fully accounted for by the tendency for consumers goods to pass in more and more complete measure through manufacturing processes and commercial exchange.

facture of goods made from agricultural raw materials. In the fourth place, the fluctuations of manufacturing output which mark the business cycle, though conspicuously greater in the industries producing capital goods than in those producing consumption goods, appear to be so considerable even in the latter industries as inevitably to involve year-to-year variations in the volume of goods passing to the consumer. These conclusions, general and tentative as they are, make a beginning in the analysis of changes in the national real income during the past twenty-one years.

Taken as a whole, the results of the study of the physical volume of manufacture are intended to suggest a practical mode of analysis rather than definitive conclusions. For the reliable measurement of the national real income, investigation must be extended to include: (a) fluctuations in the stocks held by manufacturers, jobbers, and retailers; (b) changes in the physical volume of exports and imports; (c) variations in real income in the form of personal services. Reasonable approximations, if not full measurements, of these elements are becoming more and more feasible. With these elements included, the analysis should produce highly significant results. Direct measurement of the variations of the national real income is one of the lines to be most carefully cultivated by current statistical investigation.